DEPARTMENT OF COMMERCE

# TECHNOLOGIC PAPERS

OF THE

# BUREAU OF STANDARDS

S. W. STRATTON, DIRECTOR

No. 181

## COLORED WALL PLASTER

BY

WARREN E. EMLEY, Chemist
CHARLOTTE F. FAXON, Laboratory Assistant
*Bureau of Standards*

DECEMBER 15, 1920



PRICE, 5 CENTS

Sold only by the Superintendent of Documents, Government Printing Office
Washington, D. C.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1920

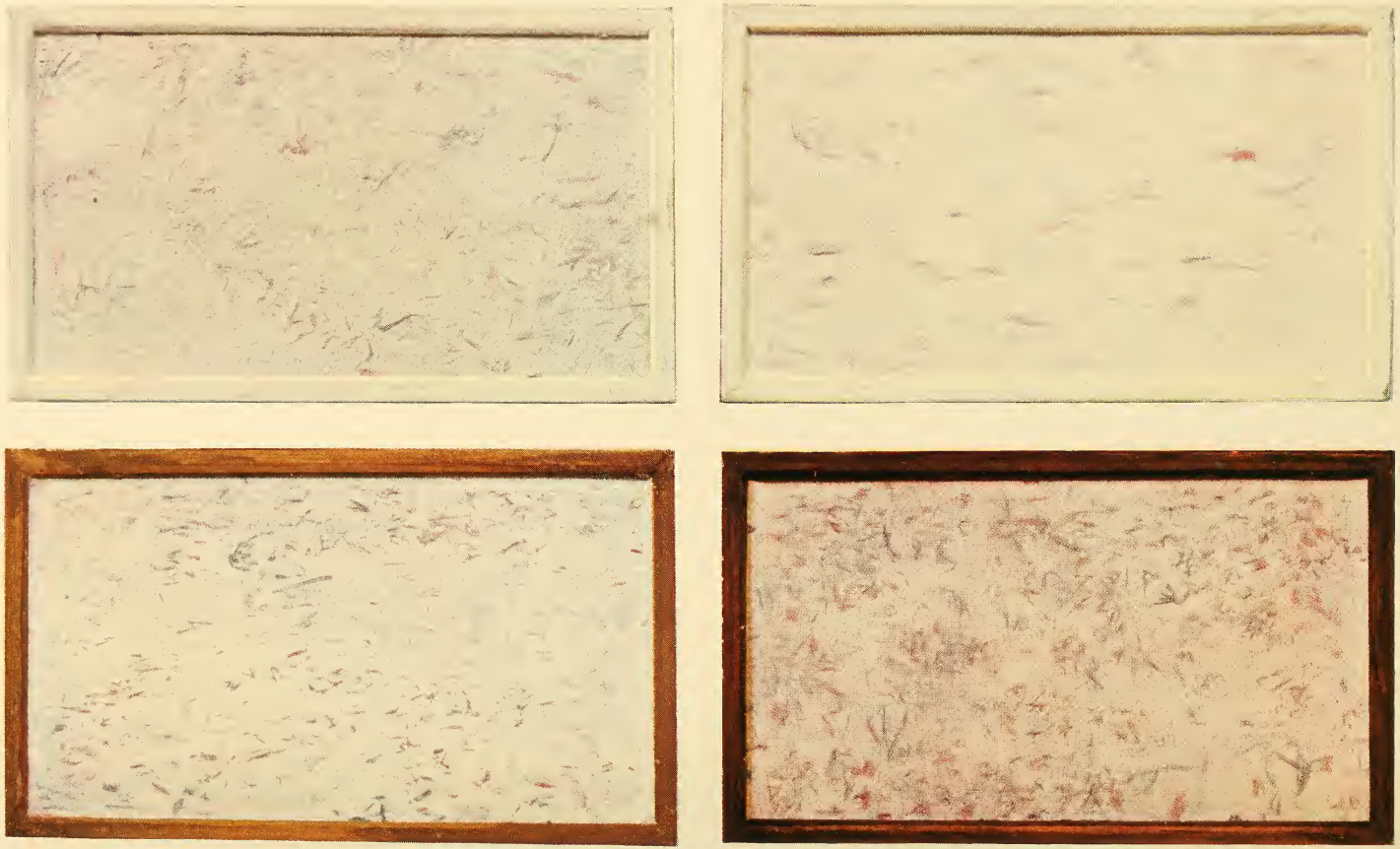

FIG. 1.—*Examples of the new type of colored wall plaster.*

# COLORED WALL PLASTER

By Warren E. Emley and Charlotte F. Faxon

The natural color of a wall plaster is white, or nearly so. For many years it has been customary to accept this white color as inevitable and to dismiss the subject without further consideration.

The quality of a plaster is indicated by its natural color in a way which is strikingly analagous to the method used for classifying diamonds. The best plasters are slightly tinted with blue; pure white plasters are of excellent quality, and the poorest grades have a buff or reddish tinge. This fact has led the plasterer and the building contractor to look with favor upon a white or bluish-white plaster because these colors are usually accompanied by excellence in quality.

On utilitarian grounds, plaster has established its position in the building industry. Its fire resistance, its heat insulating, and its acoustical properties are of primary importance. The appearance of the plaster, while admittedly and rightfully of secondary importance, is receiving more and more attention from progressive architects and builders.

The white color of plaster is sometimes objectionable in that it does not fit in with the artistic scheme which the architect is trying to evolve. It is true that the plaster may be covered with kalsomine or wall paper, but it seems to be worth while to attempt to make the plaster of the desired color in the first place.

Several attempts have been made to produce colored plaster, but the method has not proven sufficiently satisfactory to warrant its general adoption. It involves the use of a mineral pigment, which is mixed with the plastering materials. A buff or red can be obtained with oxides of iron; a gray with lampblack. It has been found extremely difficult to mix the pigment with the plaster in such a way that two batches have exactly the same tint. Deep shades of color require the addition of so much pigment that the strength of the plaster is impaired. A plaster made by this method has a dead color, which is desirable when the plaster is considered as a background for other decorations, but which has little artistic value of itself.

14946°—20

Some years ago J. J. Earley developed on a commercial scale the manufacture of colored concretes by the exposed aggregate method. Many examples of the beauty of such concretes and of the flexibility of the process can now be seen in buildings, walls, and pavements of Washington. Instead of the usual crushed stone or gravel which is used as an aggregate in concrete, he uses crushed stone which is prepared from naturally colored rocks, carefully selected and mixed to produce the desired artistic effect. After the concrete has set, the surface is removed and the colored aggregate thereby exposed. At Mr. Earley's suggestion this same principle has been applied to the manufacture of a colored wall plaster.

The first step was the selection of the proper aggregate. Fortunately, this offered no difficulty. There has been on the market for many years a material known as "gypsum wood-fibered plaster." This consists of approximately 85 per cent of calcined gypsum (plaster of Paris), 14 per cent of some material such as lime or clay added to give it the necessary plasticity, and 1 per cent by weight of wood fiber. It is one of the many commercial forms of wall plaster, and its position in the trade is so well established that tentative specifications for it have been adopted by the American Society for Testing Materials.

This plaster is usually designed to be used without sand, the wood fiber being considered as an aggregate. The fiber is quite similar to the ground wood used in making newspaper, except that the staple is a little longer.

The proposed process consists briefly of dyeing the fiber the desired color with aniline dyes, mixing it with the other ingredients, applying the plaster to the wall in the usual way, and then, after the plaster has set, removing its surface in such a way as to expose the colored fiber.

The first difficulty encountered arose from the lack of literature describing the behavior of aniline dyes on wood. Most of our experimental work was devoted to this phase of the subject—the testing of a large number of dyes. These tests were conducted by exposing half of a sample of dyed wood fiber mixed with the other ingredients of a colored plaster to direct sunlight for six weeks. The other half of the same specimen of plaster was kept covered. If, at the end of six weeks, one could not distinguish between the two halves of the sample, the dye was pronounced satisfactorily fast to light. Fastness to water is not essential; in fact, it is usually desirable that the dye shall "bleed" a little.

The color runs into the plaster surrounding the fiber, thereby making the fiber appear to be larger than it is and making it possible to obtain the desired effect with the use of less fiber than would be possible if the dye were fast to water.

It was found that wood fiber acts quite similarly to jute in taking up dyes. Any one of the classes of dyes can be used—silk, wool, cotton, or direct. A dye which is fast to light on the fiber on which it is intended to be used will usually be fast to light on wood fiber. If the dye is fast to water, it can sometimes be made to bleed slightly by drying the dyed fiber, without washing it. As a general rule, a small amount of alum added to the dye bath answers the purpose of a mordant. The heterogeneous character of the wood prevents the dye from being absorbed evenly. As will be shown in the following discussion, this is an advantage rather than a detriment, so that no leveling agent is necessary.

A general method of procedure may be illustrated as follows: In an indefinite quantity of water, dissolve an amount of dye equal to 3 per cent of the weight of the fiber. Heat the solution nearly to boiling and add the fiber. Add about 2 per cent of alum (aluminum sulphate) based on the weight of the fiber. Digest hot for about one hour and let it cool. Remove the fiber and dry it (usually without washing) in a drying oven. These directions are to be taken in a very general sense. Changes in them, to suit the different dyes, will be suggested by the directions given by the dye manufacturers, by standard textbooks, and by experience.

The kinds of dyes which may be used are illustrated by the following list of a few of the many dyes we have found satisfactory: Alizarine cyanine green G extra, alizarine cyanine yellow, alizarine cyanine irisol, crocein scarlet 3 B, rhodamine B extra, sulphur blue, diamine brown, diamine rose, naphthol orange, beta naphthol yellow, flavopurpurine, alizarine tartrazine, chloramine brown. Obviously any desired color can be obtained.

It is to be understood that these colors have proven fast to light when tested by the laboratory method described above. Before attempting any commercial application, it would, of course, be wise to determine the permanency of the dyes which it is proposed to use. This information may be obtainable from the dye manufacturers, or it may be necessary to learn from experience. Attention is called to the fact that the color need not be perfectly fast to light to give satisfactory service. If a wall is evenly exposed, so that all parts of it fade at the same rate, the fading is not a serious defect. There is also the probability that the walls will be redecorated every few years to suit the tastes of new occupants of the building.

There are a great many pure chemical compounds which have definite colors in and of themselves. A massive piece of such a compound will appear in its true color, irrespective of the viewpoint of the observer. However, most of the materials with which we are familiar are not simple substances, but are mixtures of several ingredients. This is particularly true of wall plaster. If the different ingredients have different colors, as is usually the case, then the color of the mixture will depend upon the relative amounts of the ingredients, the relative sizes and positions of the particles, and the viewpoint of the observer. A plaster which appears gray on casual observation may, on close inspection, be found to consist of a number of black specks embedded in a white matrix. If the black specks are large enough to be easily visible, then the plaster is no longer gray, but is a mottled black and white. It will be noted that the term "easily visible" defines the position of the observer. The mottled effect, which is pleasing to the eye, is obtained only when the black particles are uniformly distributed; if they are collected in large aggregates, the effect is blotchy and displeasing.

While fibers of one color only can be used, better effects can be obtained by the use of two or more different colors. In this way, the predominating color can be made more agreeable and satisfying by the use of supporting colors. Spots of the principal color should be distributed uniformly (but not in regular pattern) throughout the matrix. They should be large enough so that their identity can be distinguished without effort. Each spot should be set off by surrounding it with a number of small spots of one or more secondary colors. These should be so small that they can not be distinguished except by close inspection. The effect of the whole can be improved by giving the surface a rough texture.

Of course, due care must be taken that only those colors are used together which harmonize well with each other.

Plasters colored by this method will have "life." By this it is meant that the color of the plaster is more or less dependent upon the position of the observer; the color changes as he moves. Suppose, as the simplest case, that a plaster contains fibers of two principal, but no secondary, colors. When viewed from one direction, it is probable that one color would be reflected much more than the other and would become dominant. Viewed from another angle, the reverse might be the case. Close inspection would reveal the two colors equally. At a sufficient distance, the reflected colored lights would be superimposed, giving rise to an

entirely different color, or even to gray if the original colors are complementary.

A similar live effect can be produced by a rough surface. The protuberances cast shadows on the depressions, and thus produce light and dark tints. The intensity and the apparent magnitude of these shadows depend upon the position of the observer, and seem to vary as he moves. The life of such a surface, and its pleasing effect, is dependent upon its texture.

The above statements form a brief outline of the principles underlying the manufacture of this type of colored plaster. It will be noted that the effect desired may be described as a "uniform lack of uniformity." It is desirable that the wood fiber shall not take up the dye evenly. The principal color can be made predominant either by using a large quantity of fiber or else by using a dye which will "bleed." For the secondary colors, the fiber should be quite small and the dye fast to water, or, if the dye will bleed, the fiber may be replaced by sawdust.

The desired proportions of the different colored fibers are mixed with the calcined gypsum and other ingredients to form a gypsum wood-fibered plaster of the usual composition. This is shipped dry, mixed with lime putty and water, and applied in the usual way. Up to this point the only novelty in the manufacture of a colored plaster lies in the use of a dyed wood fiber instead of the naturally colored material. Of course care must be exercised in the selection of colors which will blend harmoniously, and in the admixture of the proper proportions of primary and secondary colors.

The desired texture of the finished surface may call for a variation in the quantity of fiber used. It will be recalled that commercial wood-fibered plaster contains about 1 per cent of fiber by weight. This is equivalent to about 15 per cent by volume. About 1 part of fiber to 1 of plaster, by volume, is the maximum amount which can be used if the surface is to be troweled smooth. If, however, a rough surface is desired, the quantity of fiber may be increased; 2 parts of fiber to 1 of plaster can be used by patting it into place.

A rough texture is produced by brushing the plaster just as it sets. This removes the gypsum from the surface and exposes the colored fibers. Differences in the quantity of fiber and in the method of brushing permit the production of a great variety of textures. We have developed three types of texture which are illustrative of variations obtainable. The "smooth finish"

is obtained by the use of a plaster containing 0.3 to 1 part by volume of fiber to 1 part of plaster. The plaster is troweled to a smooth surface in the usual way. Since this surface is not brushed, and the fiber is not exposed, it is necessary to use dyes which will bleed rather profusely. Otherwise the color will not be sufficiently pronounced. Just before the plaster has set, it may be brushed with a fiber scrubbing brush, taking care that the marks made by the brush are all either horizontal or vertical. This produces an "organdie" finish. For the "tapestry" finish, we use 2 parts of fiber to 1 of plaster. This is patted into place but can not be troweled. Just before the plaster sets it is stippled with a wire brush. The resultant surface is very rough and bears some resemblance to tapestry. These types are illustrated in the colored photograph which accompanies this paper.

It was found that a slight efflorescence appeared during the drying of the plaster, which marred the brilliance of the colors. This was overcome by washing the plaster with soap and water. The soap can be applied just before the plaster is finally troweled down, or the plaster may be allowed to harden and dry before scrubbing it. A thick solution of strong laundry soap in hot water is recommended. Apparently the soap enters into chemical reaction with the lime in the plaster forming a calcium resinate or similar gelatinous compound, which effectually closes the pores of the plaster and prevents further efflorescence.

This method of scrubbing the plaster with soap and water affords a housewife a means of brightening the walls whenever necessary.

No matter how pleasing the appearance of a wall may be, it is probable that a change in the decorative scheme will sometime be desired. When this occurs, it is only necessary to remember that a colored wall plaster is essentially the same as any other wall plaster. It may be covered with another coat of plaster, either colored or white, or it may be painted or papered in the usual way.

In conclusion, it may be stated that a method has been developed for producing a colored wall plaster of any desired color or texture. Effects can be produced with this plaster which are not attainable with either paint or wall paper. A wall finished in this plaster can be washed when the colors become dull or soiled, or it can be redecorated in the same way as any other plastered wall.

WASHINGTON, August 16, 1920.